Mean level of positive affect moderates associations between volatility in positive affect, mental health, and alcohol consumption among mothers

By: Jaclyn P. Maher, Chaelin K. Ra, Adam M. Leventhal, Donald Hedeker, Jimi Huh, Chih-Ping Chou,and Genevieve F. Dunton

Maher, J. P., Ra, C. K., Leventhal, A. M., Hedeker, D., Huh, J., Chou, C. P., Dunton, G. F. (2018). Mean level of positive affect moderates associations between volatility in positive affect, mental health, and alcohol consumption among mothers. *Journal of Abnormal Psychology, 127*(7), 639-649.

Abstract:

Affective volatility (i.e., variability) is typically conceptualized as a marker of poor mental and behavioral health. The current research challenges this notion. Among individuals who typically experience low positive affect (PA), vacillation between bouts of joy and marked anhedonia may be associated with better behavioral health relative to a restricted range of PA experience. We therefore tested the hypothesis that mean levels of PA captured via an 8-day intensive repeated Ecological Momentary Assessment (EMA) would moderate the association of EMA-measured PA variability with behavioral health measured at intake among working mothers (N = 202) with young children—a population at risk for experiencing repeated stress- and reward-induced PA changes. Mixed-effects location scale modeling parsed variance in PA mean and variability, which were used in subject-level regression models of associations with depressive symptoms, anxiety, and alcohol use. PA mean moderated the associations of PA variability with depressive symptoms (Interaction: $\beta = .20$, $p = .02$) and alcohol consumption frequency (Interaction: $\beta = .22$, $p = .02$). PA variability and depressive symptom and alcohol consumption levels were positively associated at higher PA mean levels, whereas PA variability was inversely associated with depressive symptom and alcohol consumption at low mean PA. PA Mean × Variability Interactions were not significant for anxiety and binge drinking. We conclude that (a) intensive longitudinal modeling of Affect Mean × Variability Interaction effects may provide incremental information in psychopathology research; (b) PA volatility does not unilaterally indicate poor behavioral health; and (c) a nuanced perspective on the role of PA volatility may benefit clinical services for working mothers.

Keywords: depression | alcohol | mixed-effects location scale model | Ecological Momentary Assessment | positive mood

Article:

General Scientific Summary—This study is one of the first to investigate the interactive association between mean levels and volatility in positive affect and mental health and health

risk behaviors. Results indicate that considering of mean levels of positive affect may be important for understanding how variability in positive affect influences psychological and behavioral outcomes. This study adds to our theoretical understanding of the ways in which variability in positive affect can be adaptive for individuals with low mean levels of positive affect but maladaptive for individuals with high mean levels of positive affect.

Positive affect—the experience of pleasant emotions—is crucial to mental health and subjective well-being (Fredrickson & Losada, 2005). Positive affect promotes resource building and goal pursuits (Elliot & Thrash, 2002), creative thinking and problem solving (Isen, Daubman, & Nowicki, 1987), and resiliency (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009). Deficits in positive affect have been implicated in a number of behavioral conditions, including depression, anxiety-related problems, and substance use (e.g., Garfield, Lubman, & Yücel, 2014; Pizzagalli, 2014), and are considered to be both drivers and consequences of psychopathology (Stanton & Watson, 2014). Consequently, a tendency to typically experience higher levels of positive affect (on average) is characteristically considered to be an indicator of positive mental health.

Importance of Characterizing Individual Differences in Mean Level and Volatility in State Positive Affect in Mental Health Research

While the personality literature shows that individuals possess long-term propensities toward experiencing positive affect in a variety of situations (i.e., "trait" positive affect; Lyubomirsky, King, & Diener, 2005), a given level of positive affect experienced at a momentary time point (i.e., 'state' positive affect) is a dynamic construct. For most (but not all) populations, positive affect fluctuates within-individuals across time in response to momentary pleasant events, stressors, or other stimuli (Caspersen, Pereira, & Curran, 2000; Dunton et al., 2014). One's typical within-person variability in state positive affect experience across time (i.e., affective volatility) can be considered as a source of between-person variation (Dunton et al., 2014; Hedeker, Mermelstein, & Demirtas, 2012). Hence, recent conceptualizations of individual differences in state positive affect highlight two distinct sources of interindividual variation: (a) mean level across time independent of volatility; and (b) volatility (i.e., variability) across time independent of mean level (see Figure 1).

Lack of Consensus of Whether Positive Affect Volatility Signifies Good or Poor Mental Health

While there is a general consensus regarding the benefits of high mean levels of positive affect, whether greater variability in positive affect is indicative of adaptive or maladaptive behavioral functioning is not clear (e.g., Gruber, Kogan, Quoidbach, & Mauss, 2013; Kashdan & Rottenberg, 2010; Kuppens, Allen, & Sheeber, 2010). Volatility in positive affect may represent maladaptive functioning, as reflection of: (1) a frailty of the affective processing system indicative of hyper-sensitivity to the effects of subtle changes in external and internal states on affect, or (2) an endogenous propensity toward affective vacillation that may be context independent. Gruber et al. (2013) found that day-to-day intraindividual variability in positive affect was associated with greater depression and anxiety symptoms among two nonclinical samples, suggesting that positive affective volatility may be a marker of poor emotional health.

Alcohol consumption levels have also been positively associated with variability in positive affect in nonclinical populations, which could be explained by an aggregation of episodes of alcohol use that cause or result from momentary changes in positive affect states or by a shared set of risk factors that contribute to affective volatility and liability to alcohol use (Gottfredson & Hussong, 2013).

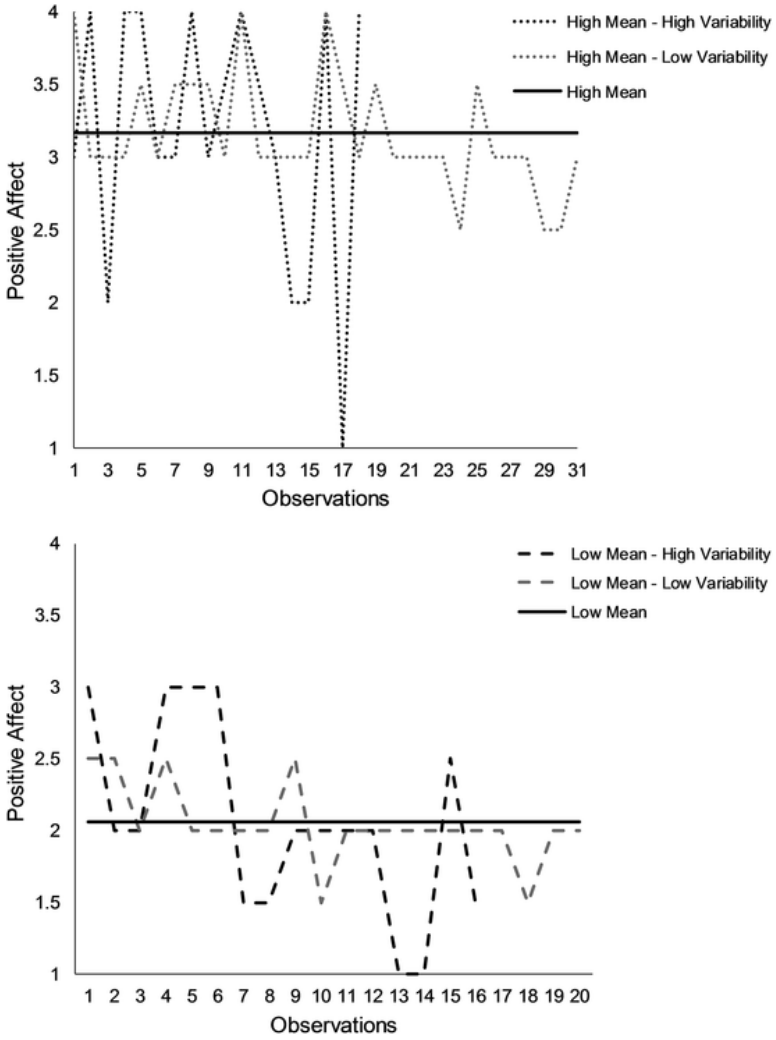

Figure 1. An example of interindividual differences in mean levels and volatility in EMA ratings of positive affect. The top panel displays EMA ratings of positive affect for two individuals with relatively high mean levels of positive affect but different degrees of variability in positive affect. The bottom panel displays EMA ratings of positive affect for two individuals with relatively low mean levels of positive affect but different degrees of variability in positive affect.

Variability in positive affect has also been argued to be an indicator of adaptive psychological functioning among healthy adults and may reflect emotional flexibility or the ability to respond flexibly to changing circumstances (Kashdan & Rottenberg, 2010). Changes in positive affect in response to perceived shifts within the environment spur action to adaptively respond to dynamic contexts. Affective variability may also signal the capacity to express changes in emotion and is considered the healthy standard compared to restricted positive affect range, such as in the case

of anhedonia whereby individuals are insensitive to the effects of rewarding environmental cues on positive affect (Kuppens et al., 2010). In a study of normal and clinically depressed adults, Lawton, Parmelee, Katz, and Nesselroade (1996) found that individuals with major depression displayed significantly less variability in daily ratings of positive affect compared to individuals with mild or no depressive symptoms. Such findings raise the possibility that diminished positive affect volatility may be an indicator of a dormant affective processing symptom.

Conflicting evidence and conceptualizations of whether fluctuations in positive affect are adaptive or maladaptive to mental health could be explained by vital moderators. We propose what we feel is an intuitive candidate moderator of the association between positive affect variability and mental health—one's mean level of state positive affect collapsed across time and instances.

Mean Level of State Positive Affect as Candidate Moderator of the Association of Positive Affect Volatility with Emotional Symptomatology and Alcohol Consumption

Volatility (i.e., variability) in positive affect may be an indicator of adaptive psychological functioning within the subpopulation of individuals with low mean levels of positive affect. Among those with low mean levels of positive affect, volatility signifies responsive to changing contextual factors and able to experience higher than mean levels of positive affect. People with low mean and high variability positive affect may vacillate between experiencing temporary states of marked anhedonia and momentary states of joy. Such a pattern of affective experience may signal a nondormant affective processing system that is responsive to contexts. For such individuals, perhaps the cumulative effects of brief states of joy may have lasting effects that counterpoise states of marked anhedonia to contribute protect against emotional symptomatology, such as depression and anxiety, and satiate urges to consume alcohol to enhance positive affect. By contrast, people with low mean positive affect with little volatility reflects a chronic restricted affect state of low-to-moderate levels of positive affect without temporary bouts of joy or brief episodes of marked anhedonia. Such individuals may not reap the protective benefits of momentary episodes of joy and thus be more prone to depression and anxiety symptoms and possess a drive to consume alcohol for affect enhancement.

Among individuals with higher mean levels of positive affect, lower affective volatility may indicate psychological stability and a constant level of adaptive positive affect with little or no temporary bouts of affective deficiency. If periods of positive affective deficiencies represent vulnerability to psychopathology or maladaptive emotion-regulation behaviors, such as alcohol consumption, high-mean/low-variability positive affect populations may be resilient to behavioral conditions. For high-mean positive affect individuals, high variability in positive affect may represent affective vacillations between extreme states of joy and temporary periods of moderate or lower positive affect that could suggest episodes of feeling less satisfied with life. High-mean/high-variability positive affect populations could also capture those with a propensity toward other illnesses characterized by repeated states of high positive affect and reward seeking (e.g., mania, attention-deficit/hyperactivity disorder, substance use problems; Gruber, Johnson, Oveis, & Keltner, 2008).

Methods for Characterizing Mean Affect, Affect Volatility, and Their Interaction as Correlates of Mental Health

To the best of our knowledge, no prior study has examined whether mean affect moderates the association between affective volatility and mental health problems. Real-time data capture strategies such as Ecological Momentary Assessment (EMA) are designed to repeatedly assess momentary experiences and events as they occur naturally within the content of everyday life (Stone & Shiffman, 1994). Such an approach yields a relatively large number observations within each subject otherwise known as intensive longitudinal data. Intensive longitudinal designs whereby samples provide repeated reports of momentary affective states multiple times per day provide a rich data source for modeling variance in person-level mean and variability parameters across time (Hedeker, Mermelstein, & Demirtas, 2008; Hedeker et al., 2012; Penner, Shiffman, Paty, & Fritzsche, 1994). While person-level mean and variability estimates in state affect are nonredundant sources of variance, they have been shown to be moderately correlated with one another (Hedeker et al., 2008, 2012). Hence, statistical controlling for the covariance between mean and variability parameters is important to understand their unique effects as well as their interactive effects. Mixed-effects location scale modeling incorporates a log-linear structure for determinants of both the between- and within-subject variance (Hedeker et al., 2008; Hedeker & Nordgren, 2013). More importantly, this modeling approach includes a random subject effect for the within-subject variance specification (Hedeker et al., 2008). This allows the within-subject variance to vary at the subject level which can then be modeled as a person-level predictor, along with traditional predictors such as person-level mean (Hedeker & Nordgren, 2013). Therefore mixed-effects location scale models have useful applications where interest centers on the joint modeling of the mean and variance structure.

Women With Young Children Are a Population Liable to Experience Affective Volatility and Poor Mental Health

Mothers of young children represent a particularly vulnerable population for experiencing affective volatility and mental health problems. First, women are more likely to experience more intense affective states (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000) and greater affective lability (Carstensen et al., 2011) compared to men. Beyond that, mothers typically represent the primary care givers for children (Bianchi, 2000) and may be more susceptible to experiencing the emotional highs and low associated with parenthood (Rutherford, Wallace, Laurent, & Mayes, 2015). For example, data from the American Time Use Survey indicated that mothers experience greater momentary well-being (i.e., greater momentary feelings of happiness and lower momentary feelings of sadness and stress) when they are with their child(ren) compared to times when they are not with their child(ren); however, mothers reported greater momentary feelings of stress and fatigue compared to fathers (Musick, Meier, & Flood, 2016).

Women in their childbearing years are also more susceptible to experiencing mental health problems such as depression or anxiety disorders. Globally, depression is second only to HIV/AIDS in terms of total disability among women aged 15 to 44 years and in the United States depression is the leading cause of nonobstetric hospitalization among women age 18 to 44 years (Kendall-Tackett, 2016). Moreover, nearly one third of adults between the ages of 18 and 44 have experienced an anxiety disorder and women are 60% more likely than men to experience an

anxiety disorder over their lifetime (Kessler et al., 2005). The presence of mental health issues among mothers is important given its implications for the development of psychopathology among children (e.g., Cummings & Davies, 1994).

The Present Study

In this secondary analysis of a community sample of mothers with young children, the present report utilized intensive repeated measures positive affect data collected through EMA as well as data from questionnaire measures of depressive symptoms, anxiety, and alcohol use administered at an intake visit. We test the hypothesis that the association between subject-level variability (i.e., intraindividual variability) in positive affect and depressive symptoms, anxiety, and alcohol consumption would be moderated by mean levels of positive affect (i.e., subject-level mean), such that the association between positive affect volatility and mental health would trend toward a positive direction at higher mean affect level and trend toward a negative direction at a lower mean affect level. A two-stage approach employing mixed-effects location scale modeling (Hedeker & Nordgren, 2013) was used to simultaneously model subject-level mean and variability in positive affect and their interactive associations with subject-level indicators of mental health.

Method

Study Overview

This secondary data analysis was conducted among mothers from the Mothers' and Their Children's Health Study (MATCH). MATCH uses EMA in addition to other sampling techniques to understand the effects of parental stress on children's physical activity and eating behaviors at the within-day level that contribute to children's long-term obesity risk (Dunton et al., 2015). Though the primary aims of the MATCH study are different from the aims of the present study, the present study represents an opportunity to maximize the information contained in EMA data from MATCH that aligned with our a priori, novel research questions.

Participants

Participants were mothers of children attending public elementary schools and afterschool programs in the greater Los Angeles metropolitan area. Inclusion was based on the following criteria: (a) the child was in third through sixth grade; (b) the mother had ≥50% custody of the child; and (c) mother and child were able to read English or Spanish. Exclusion was based on the following criteria: (a) either mother or child were currently taking medications for thyroid function or psychological conditions, had health issues that limited physical activity, were enrolled in special education programs, or were currently using oral or inhalant corticosteroids for asthma; (b) mothers were pregnant; (c) children classified as underweight by a BMI percentile <5% adjusted for sex and age; and (d) mothers who worked 2 + weekday evenings per week or 8 + hours on any weekend day.

Procedures

Mothers interested in participating in the study were screened for eligibility by phone. Eligible mothers and their children were asked to attend an in-person data collection session. At this session, mothers completed a paper-and-pencil questionnaire, anthropometric assessments, and received instructions for smartphone-based EMA protocol which they are asked to complete over the next eight days. As part of the EMA protocol mothers received random prompts through an auditory signal on the smartphone to complete a brief electronic questionnaire up to 8 times per day (8 questionnaires on weekend days occurring between 7:00am and 9:30 p.m., 4 questionnaires on weekdays occurring during nonschool hours between 3:00 p.m. and 9:30 p.m.). Each electronic questionnaire consisted of up to 31 questions about mother's current affect, behaviors, context, and parenting practices and took approximately 3 minutes to complete. If participants did not respond to the initial auditory signal, participants were reprompted two additional times at 3-minute intervals. If participants did not answer the brief electronic questionnaire within 10 minutes of the initial auditory signal, the questionnaire became inaccessible until the next prompt. At the same time, children answered EMA prompts on a similar schedule but those data are reported elsewhere (Dunton et al., 2016).

EMA data were collected through a custom software application (app) for smartphones running the Android operating system (Google Inc., Mountainview, CA). Participants without a compatible smartphone or not wishing to use their own smartphone for the study were loaned a Motorola MotoG (Motorola Mobility, Chicago, IL) smartphone. Mothers who owned compatible Android smartphones were given the option to complete the EMA surveys directly from their personal phones (11% of participants chose this option). Mothers were given the option to use the app in English or Spanish (6% of mothers chose Spanish). All study procedures were approved by the University of Southern California's Institutional Review Board (HS-12–00446).

Measures

Positive affect. Mothers' positive affect was assessed through EMA. Items assessing positive affect were based on the circumplex model (i.e., valence and arousal) of the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) with response options on a 4-point Likert scale ranging from 1 (*not at all*) to 4 (*extremely*). Positive affect was assessed with two items (i.e., "Right before the phone went off, how HAPPY were you feeling?", "Right before the phone went off, how CALM/RELAXED were you feeling?"). These items were selected to capture positive activated affect (e.g., happy) and positive-deactivated affect (e.g., calm), while limiting participant fatigue and burden typically associated with EMA protocols. Responses to the domains of positive affect through EMA were internally consistent ($\Omega = 0.68$), so a composite score was created by averaging the responses together.

Mental health. *Depression* was assessed using the 20-item Center for Epidemiologic Studies Depression Scale (CESD; Radloff, 1977). Participants were asked how often they felt a particular way in the past week (e.g., "I felt that I could not shake off the blues even with the help of friends and family") on a scale ranging from 0 (rarely or none of the time) to 3 (most or all of the time). The 20-item measure is designed to assess symptoms of depression including dysphoria, anhedonia, appetite, sleep, thinking/concentration, guilt, fatigue, agitation, and suicidal ideation. Responses displayed a high level of internal consistency ($\alpha = .92$) and were summed. For secondary analysis, three subscales (somatic, negative affect, and interpersonal

symptoms) that were identified by a recent meta-analysis of the factor structure of the CESD, which is consistent with Radloff's (1977) original four-factor structure, were also derived (Shafer, 2006). *Anxiety* was assessed using the 20-item State–Trait Anxiety Inventory, a validated measure of anxiety in adults (Spielberger, 1989). Participants were asked to indicate how often they felt a particular way in the past week (e.g., "I felt inadequate") on a scale ranging from 1 (almost never) to 4 (almost always). Responses were internally consistent ($\alpha = .92$) and summed to create a composite score. *Frequency of drinking occasions* over the past month was assessed using a single item (i.e., "How often during the past month did you have a drink containing alcohol?"; Johnston, O'Malley, Bachman, & Schulenberg, 2010). Response options included: "never", "monthly or less", "2–4 times per month", "2–3 times per week", and "4 or more times per week". Responses were the recoded to provide the following numeric values for number of drinking occasions in the past month: 0 (*never*), 1 (*monthly or less*), 3 (*2–4 times per month*), 10 (*2–3 times per week*), and 16 (*4 or more times per week*). Binge drinking in the past month was assessed with a single-item (i.e., "During the past month, how often did you have six or more drinks in one occasion?"; Johnston et al., 2010). Mothers indicated that they had engaged in at least one binge drinking occasion were coded as 1, whereas mothers who did not indicate binge drinking in the past month were coded as 0.

Demographic characteristics. Mothers completed paper-and-pencil questionnaires assessing age, ethnicity, household type, employment status, education level, and annual household income (some participants [$n = 73$] were asked about their income in 2012 which occurred one to two years prior to participation in the study).

Data Analysis

This study employed a two-stage data analysis approach using the standalone program MIXWILD. The first stage used mixed-effects location scale modeling to estimate a subject's mean (location) and variability (scale), and the second stage integrated these estimated location and scale effects into a subject-level linear or logistic regression (Hedeker & Nordgren, 2013). The first stage model was executed using the MIXREGLS program (for more details on this modeling approach see Hedeker & Nordgren, 2013). Specifically, in the first stage, an empty model with no covariates was tested to disaggregate the within-subject (WS) mean level as well as between-subjects (BS) and WS variances in positive affect (i.e., a momentary prompt-level outcome; Hedeker & Nordgren, 2013). In the second stage, a subject's mean level and variability in momentary positive affect (estimated in the first stage model) as well as the interaction between their mean level and variability in positive affect were used to predict subject-level aspects of mental health (i.e., depression, anxiety) and health risk behaviors (i.e., volume of alcohol consumption, binge drinking). Four separate second stage models were tested, one for each subject-level outcome of interest. All second stage models were tested as linear regression models, except for the model with binge drinking as the outcome in which a logistic regression was tested in the second stage. Positive affect variables (both mean level and variability in) were standardized along with maternal mental health and frequency of alcohol consumption variables to facilitate the comparison of results between models. The binge drinking variable was not standardized because these variables were dichotomized and thus had a meaningful zero.

Subject-level covariates (i.e., age, ethnicity, household type, employment status, education level, annual household income, and number of children) to include in the second stage model were screened based on significant bivariate correlations with subjects' mean level and variability in positive affect as well as study outcomes ($p < .05$). As a result, adjusted second stage models controlled for income quartiles (i.e., $0–$34,999, $35,000–$74,999, $75,000–$104,999, $105,000+), household type (single-parent vs. dual-parent/multigenerational) and education (college vs. no college).

Resampling was conducted as an additional step to strengthen confidence in the estimates of the original model. Resampling accounts for the fact that the first-stage analysis generates subject-level random effects as estimated quantities, which are then used as predictors in the second-stage analysis. As estimated quantities, these estimates can have varying degrees of uncertainty (Carsey & Harden, 2013). For example, if a particular subject does not have many observations in the first-stage analysis, their random effect estimates will have more uncertainty relative to a subject that has many observations. Therefore, for each subject, the random effects were resampled 100 times to generate random effects estimates (and standard errors) the random effects were resampled. These resampled data were then used to rerun the second-stage modeling procedure 100 times. Results were then averaged for the coefficients and standard errors across the resamples.

Results

Data Availability and Participant Characteristics

There were 202 mothers enrolled in the study at baseline. Of those, 11 mothers provided no positive affect data across the EMA protocol (2 due to malfunction and 9 due to nonresponse). Of mother's providing EMA data on positive affect ($n = 191$), mothers answered an average of 78.2% (range 3.4% – 100%) of delivered EMA prompts. Additionally, due to missing demographic information ($n = 7$) as well as incomplete paper-and-pencil questionnaire data regarding outcomes of interest, the final analytic sample sizes for each series of models ranged from 171 (anxiety) to 184 (drinking) participants. Of participants providing valid EMA data and demographic information, mother's age ranged from 24 to 57 years (M = 40.9 years, $SD = 6.2$). Approximately half of mothers identified as Hispanic or Latina (49.2%). The majority of mothers were a part of two-parent households (62.8%) while 23.6% of mothers were single-parents and 13.6% were apart of multigenerational households. Sixty percent of mothers reported attending attended college. More than half of the sample reported working full-time (56.4%). Median annual household income in the sample ranged between $65,000 and $74,999.

On average, mothers reported relatively low-to-moderate levels of depressive symptoms (M = 7.9 on a 0 to 60 scale; $SD = 8.3$) and anxiety (M = 37.1 on a 20 to 80 scale; $SD = 9.5$). Participants reported approximately four drinking occasions, on average, within the past month (M = 3.9 occasions; $SD = 6.8$). Almost one third of the sample reported no drinking occasions at all within the past 30 days ($n = 55$) whereas 6.6% of the sample reported consuming alcohol daily over the past month ($n = 12$). Eight percent reported at least one binge drinking episode in the past month.

There were a total of 4,186 valid observations with positive affect data. Across all observations, not accounting for the nesting of occasions within people, mothers reported moderate levels of positive affect (M = 2.6 on a 1 to 4 scale; *SD* = 0.7). The intraclass correlation (ICC) was 0.34, indicating that approximately two thirds of the variance in positive affect occurred within subjects.

Correlations among key mental health and behavioral variables as well as mean levels of positive affect and relevant covariates are displayed in Table 1.

Table 1. Descriptive Statistics and Correlations Between Maternal Mental Health and Behavioral Variables, Mean in Positive Affect, and Other Key Variables

Variables	*M* (%)	*SD*	1	2	3	4	5	6	7	8	9	10
1. Depressive symptoms	7.9	8.3	1.00									
2. Anxiety	37.1	9.5	.80*	1.00								
3. Drinking occasions in the past month	3.9	6.8	−.05	−.10	1.00							
4. Binge drinking	8.4%	—	.25*	.18*	.02	1.00						
5. Mean positive affect	2.6	.7	−.39*	−.43	−.01	−.05	1.00					
6. Age	40.9	6.2	.01	−.08	.09	−.17*	−.04	1.00				
7. Ethnicity	49.2%	—	.04	.06	−.14	.09	−.02	−.38*	1.00			
8. Single parent household	23.6%	—	.16*	.17*	−.04	−.02	−.16*	.03	.04	1.00		
9. Work full time	56.4%	—	−.01	−.01	−.02	−.04	−.03	−.20*	.01	.06	1.00	
10. Income	$65,000–$74.999	—	−.29*	−.21*	.16*	−.07	.10	.21*	−.29*	−.40*	.04	1.00
11. Attended college	56.5%	—	−.19*	−.17*	−.02	−.19*	.16*	−.28*	−.38*	−.09	.01	.46*

Note. Data displayed in this table are based on 174 to 191 subjects, depending on the variable, due to missing data. Higher composite scores for depressive symptoms and anxiety indicate greater feelings of depressive symptoms or anxiety, respectively. Frequency of alcohol consumption refers to the number of days in the past month participants consumed alcohol. Binge drinking refers to if a participant consumed 6+ drinks in one sitting in the last past month. Binge drinking, ethnicity, household type, and employment status are dichotomous variables with engaging in binge drinking, being Hispanic, being in a single-parent household, working full time, and attending college representing the higher value.
*$p < .05$.

Positive Affect Mean Level and Variability Main Effects and Interaction Effects for Association With Mental Health

Results from the original second stage models as well as results from resampling are shown in Table 2. All adjusted models control for income quartiles, household type, and education level.

Depressive symptoms. Based on results from the original model, the mean level of positive affect main effect was significantly negatively associated with depressive symptoms (β_{Mean} = −0.35, $p < .001$, 95% CI [−0.49, −0.21]); whereas variability in positive affect main effect did not significantly predict depressive symptoms. In addition, the association between variability in positive affect and depressive symptoms varied as a function of mean levels of positive affect ($\beta_{Mean \times Variability\ Interaction\ term}$ = 0.20, $p = .02$, 95% CI [0.02, 0.38]). More specifically, the magnitude of the relationship between variability in positive affect and depressive symptoms increased (i.e., became more positive) for individuals with higher mean levels of positive affect, but for individuals with low mean levels of positive affect the association between variability in positive affect and depressive symptoms became more negative (see Figure 2).

Table 2. Modeling Associations Between Mean Level and Variability in Positive Affect and Mental Health and Behavioral Outcomes

Key variables	Adjusted models			Adjusted models with resampling		
	Estimate	Standard Error	*p*-value	Estimate	Standard Error	*p*-value
Depressive symptoms (n = 178)						
Intercept	−.01	.07	.99	.37	.14	.01
Positive affect mean	−.35	.07	<.001	−.42	.07	<.001
Positive affect variability	.10	.08	.20	.06	.08	.41
Positive Affect Mean × Variability Interaction	.20	.09	.02	.17	.09	.05
Anxiety (n = 171)						
Intercept	−.02	.06	.80	.27	.14	.05
Positive affect mean	−.40	.08	<.001	−.44	.07	<.001
Positive affect variability	.21	.08	.01	.18	.08	.03
Positive Affect Mean × Variability Interaction	.11	.09	.23	.09	.09	.31
Frequency of alcohol consumption (n = 177)						
Intercept	−.35	.20	.08	−.19	.14	.19
Positive affect mean	.06	.08	.4	−.03	.07	.68
Positive affect variability	.07	.08	.38	.01	.08	.87
Positive Affect Mean × Variability Interaction	.22	.09	.02	.18	.09	.06
Binge drinking (n = 184)						
Intercept	−1.58	.84	.06	−1.56	.59	.01
Positive affect mean	−.12	.36	.73	−.36	.34	.30
Positive affect variability	.34	.38	.37	.20	.40	.60
Positive Affect Mean × Variability Interaction	.51	.32	.12	.40	.35	.24

Note. Estimates for depressive symptoms, anxiety, and frequency of alcohol consumption in the past 30 days were standardized (M 0, SD 1) and served as the outcome variable in separate linear regressions. Binge drinking in the past 30 days and was the outcome variable in a logistic regression. Models control for income quartiles, household type (single-parent vs dual-parent/multigenerational) and education (college vs no college).

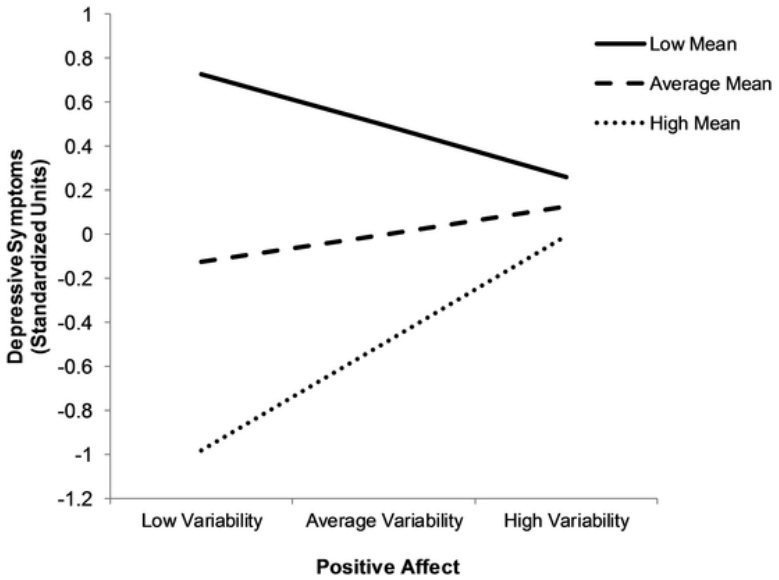

Figure 2. Interaction between mean level and variability in positive affect predicting depressive symptoms. Low and high mean and variability refer to 1.5 standard deviations below and above the mean, respectively.

Because deficient positive affect is a component of depression (Shafer, 2006), secondary analyses that utilized CESD depressive symptom subscales for somatic features, interpersonal problems, and negative affect were conducted to elucidate whether the Positive Affect Mean × Variability Interaction term was associated with the three nonpositive affect symptom domains

captured by the CESD. Reported in detail in the online supplemental materials, results from the original model indicated that the association between variability in positive affect and negative affect subscale and somatization subscale varied as a function of mean level of positive affect (Negative Affect: $\beta_{\text{Mean}\times\text{Variability Interaction term}} = 0.20$, $p = .02$, 95% CI [0.02, 0.38]; Somatization Features: $\beta_{\text{Mean}\times\text{Variability Interaction term}} = 0.22$, $p = .01$, 95% CI [0.02, 0.40], respectively).

Anxiety. Based on results from the original model, the positive affect mean level main effect was negatively associated with anxiety ($\beta_{\text{Mean}} = -0.40$, $p < .001$, 95% CI [−0.56, −0.34]), whereas positive affect variability main effect was positively associated with anxiety ($\beta_{\text{Variability}} = 0.21$, $p = .01$, 95% CI [0.05, 0.37]). The interaction between mean levels and variability in positive affect was not significantly associated with anxiety.

Frequency of drinking occasions. Based on results from the original model, the main effects of mean level and variability in positive affect were not associated with frequency of drinking occasions in the past 30 days. The association between variability in positive affect and frequency of drinking occasions varied as a function of mean levels of positive affect ($\beta_{\text{Mean}\times\text{Variability Interaction}} = .22$, $p = .02$, 95% CI [0.04, 0.40]). More specifically, the strength of the relationship between variability in positive affect and frequency of alcohol consumption is increased (or became more positive) for individuals with higher mean levels of variability in positive affect (see Figure 3).

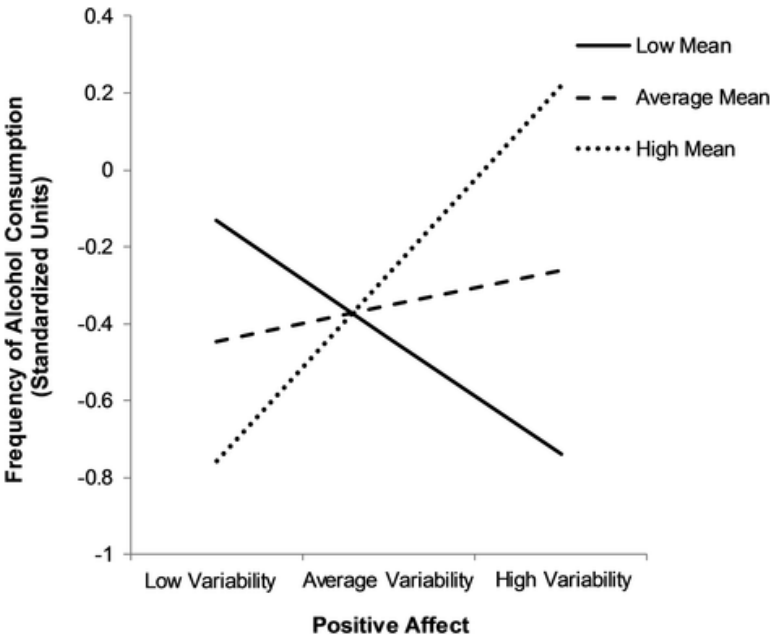

Figure 3. Interaction between mean level and variability in positive affect predicting frequency of alcohol consumption in the past 30 days. Low and high mean and variability refer to 1.5 standard deviations below and above the mean, respectively.

Binge drinking. Based on results from the original model, neither mean level or variability in positive affect were significantly associated with odd of engaging in binge drinking within the past month. Additionally, the interaction between mean level and variability in positive affect was not significantly related to binge drinking behavior.

Resampling. Results from resampling were similar with coefficients in the same direction as in the original model although the size of beta coefficients did decrease and the *p* values did increase slightly. Central to the main research questions of this article, the interaction between mean level and variability in positive affect nonsignificantly predicted depressive symptoms ($\beta_{\text{Mean×Variability Interaction}} = .17$, $p = .05$, 95% CI [−0.01, 0.35]) and frequency of alcohol consumption ($\beta_{\text{Mean×Variability Interaction}} = .18$, $p = .06$, 95% CI [0.00, 0.36]).

Discussion

This study provides the first known evidence that associations between volatility in positive affect and psychological and behavioral outcomes may vary as a function of one's mean levels in positive affect. Previous work in nonclinical populations has been equivocal regarding the role of variability in momentary ratings of positive affect on aspects of health and well-being (Gruber et al., 2013; Kashdan & Rottenberg, 2010; Kuppens et al., 2010). This study helps to further disentangle the associations between these constructs by exploring the role of mean level as a moderator Although this study sampled individuals with relatively healthy psychological and behavioral health profiles, the current study extends previous work by demonstrating that greater variability in positive affect may be adaptive for those with low means levels of positive affect but maladaptive for those with high mean levels of positive affect. The novel methodology and results from this study have broad implications for future research aiming to understand the dynamic nature of emotion and its relationship with health and well-being in both clinical and nonclinical populations. The novel methodological and analytical approach employed in this article can be applied to a variety of populations as well as research in psychopathology that utilize real-time data capture methodology.

Affective volatility is considered a possible cause of nonclinical depression (Costello, Benjamin, Angold, & Silver, 1991; Eid & Diener, 1999). Results from this study indicated that, for mothers with high mean levels of positive affect, depressive symptoms were higher among mothers with high variability in positive compared to mothers that had low variability in positive affect. Conversely, among mothers with low mean levels of positive affect, depressive symptoms were higher among mothers with low variability in positive compared to mothers that had high variability in positive affect. Sensitivity analyses suggest that these associations between positive affect and depressive symptoms may be driven largely by the negative affect and somatization features CESD subscales (see online supplemental materials). These results suggest that the simple presence of affective variability is not maladaptive regarding depressive symptoms, rather the consequences of affective variability depend on one's typical level of affect. Previous studies in nonclinical populations investigating associations between variability in positive affect and mental health outcomes did not explore the potential moderating role of mean levels positive affect in these associations (Eid & Diener, 1999; Gruber et al., 2013). Individuals with greater variability in positive affect coupled with high mean levels of positive affect may experience affective vacillations between extreme states of joy and temporary periods of moderate or lower positive affect. These momentary emotional declines may be maladaptive among nonclinical populations in that they signal psychological instability and an inability to cope with changes within one's environment (Gruber, Mauss, & Tamir, 2011). Conversely, greater variability in positive affect coupled with low mean levels of positive affect responsiveness to changing

contextual factors and able to experience higher than mean levels of positive affect. Therefore, despite overall low levels of positive affect, these individuals may experience the cumulative effects of brief states of joy and pleasure leading to a more adaptive psychological profile.

It is possible that these same pathways may be responsible for potential interactive effects of mean levels of and volatility in positive affect on anxiety. Although the interaction between mean level of and variability in positive affect was not significantly related to anxiety in this study, the effect size of the coefficient was smaller than that of depression and it may be that this study was not adequately powered to detect that association. Further research is necessary to replicate these finding as well as explore potential mechanisms underlying associations between mean levels of positive affect, volatility in positive affect, and mental health outcomes such as depression and anxiety.

This study is also one of the first to investigate whether associations between volatility in positive affect and alcohol consumption related-behaviors varied as a function of mean levels of positive affect. Results from this study indicated that, for mothers with high mean levels of positive affect, frequency of drinking occasions was higher among mothers with high variability in positive affect compared to mothers that had low variability in positive affect. Conversely, among mothers with low mean levels of positive affect, frequency of drinking occasions was higher among mothers with low variability in positive compared to mothers that had high variability in positive affect. Previous research among nonclinical populations has documented that affective variability is associated with greater risk for development of alcohol dependence symptoms (Simons, Carey, & Wills, 2009) as well as increased frequency of alcohol consumption (Jahng et al., 2011) and self-reported drinking to cope (Gottfredson & Hussong, 2013). Work by Mohr, Arpin, and McCabe (2015) in community-dwelling adults has also documented that greater affective variability, specifically in positive affect, is positively associated with alcohol consumption (both solitary and social). However, none of these studies have investigated the moderating role of mean levels of positive affect in associations between variability in positive affect and alcohol related behaviors. For individuals with high mean levels of and high variability in positive affect, frequent alcohol consumption may serve a way to dampen momentary changes in affect as a result of changing context (Curtin, Patrick, Lang, Cacioppo, & Birbaumer, 2001; Gottfredson & Hussong, 2013). Steele and Josephs' (1990) theory of alcohol myopia suggests that alcohol consumption limits unwanted cognitions which may be especially desirable for individuals experiencing frequent negative shifts in affective states. However, for individuals with low mean levels but high variability in positive affect, experiencing momentary increases in positive affect may represent welcomed affective states. Future research is necessary to illuminate mechanisms linking mean levels of positive affect, variability in positive affect, and frequency of alcohol consumption.

Moreover, the majority of studies investigating affective volatility and drinking behaviors have been conducted in among college students (Gottfredson & Hussong, 2013), whose frequency of drinking is much higher than adults (Substance Abuse and Mental Health Services Administration, 2013), or among samples where participants were considered moderate-to-heavy drinkers (Mohr et al., 2015). Therefore, null associations documented in this study regarding variability in positive affect and binge drinking may be the results of sampling a population with a minimal occurrence of binge drinking. Expanding the samples in which associations between

mean levels of and variability in positive affect and health risk behaviors are examined will lead to a more comprehensive understanding of contexts in which affective variability is adaptive or maladaptive in specific populations.

Regarding practical implications, the findings from this study provide a nuanced perspective on the role of positive affect volatility which may ultimately benefit clinical services for working mothers. Working mothers with low mean levels and low variability as well as mothers with high mean level and high variability in positive affect represent a subset of mothers that may have inadequate resources and support (e.g., tangible, emotional, informational) available to them to cope with daily events, hassles, and stressors. The results from this study may serve as a starting point for tailoring workplace wellness programs as well as counseling and clinical services.

Although this study provides valuable insights into the dynamics of positive affect in women, it is not without limitations. First this study focused exclusively on mothers with children. Although this is an important subsample of women to focus on because mothers often serve as primary caregiver of children and as a result are role models and gate keepers for a variety of health behaviors (e.g., Bianchi, 2000; Maher et al., 2017; O'Connor et al., 2017), results from this study are not generalizable to other women or men. Furthermore, we recognize that the sample included in this study exhibited relatively low levels of poor mental health and maladaptive health behaviors (although these rates probably reflect levels among the general nonclinical population of adults). However, this research is novel with respect to the methodology and analytic approach employed in this study. This paper, in part, represents an empirical example of how to investigate differences in associations between volatility in positive affect, mental health, and alcohol consumption as a function of mean levels of positive affect. This type of approach can be applied to a variety of other populations, both clinical and nonclinical, to provide novel insights into dynamic nature of affect in everyday life as well as inform practical applications for intervention. Therefore, future research would benefit from rigorously exploring differences in associations between volatility in positive affect, mental health, and alcohol consumption as a function of mean levels of positive affect in populations that exhibit higher levels of depressive symptoms as well as alcohol consumption. Furthermore, the methods and results highlighted in this study also have implications for research in psychopathology that currently utilize real-time data capture methodologies to assess affective volatility but have not considered mean levels of affect, leading to critical insights related to how the two may interact.

Due to the primary objective of the MATCH study, mothers were assessed through EMA during the times when they were most likely to be with their child (after 3:00 p.m. on weekdays and all day on weekend days). Therefore, the sampling protocol did not allow for assessment of positive affect during weekday mornings or afternoons. It is possible that affect during common activities that take place during weekday mornings and afternoons such as work may systematically influence either mean levels of or variability in positive affect (Amabile, Barsade, Mueller, & Staw, 2005). Additionally, to minimize participant fatigue and burden, items assessing positive affect were limited to two items. Additionally, to minimize participant fatigue and burden, items assessing positive affect were limited to two items. These items were selected to capture positive activated affect (e.g., happy) and positive-deactivated affect (e.g., calm), while limiting participant fatigue and burden. Although these items have been used to assess positive affect in

previous research (Liao, Shonkoff, & Dunton, 2015), only including two items may limit the representativeness as well as provide less fine gradations in the positive affect construct (Ekkekakis, 2013). Future research regarding variability in positive affect would benefit from more broadly sampling affective domains within the positive affect construct. Frequency of alcohol consumption was assessed with a single-item measure. This measure was derived from the Monitoring Our Future national survey and has been used widely to assess alcohol consumption in national samples (Johnston et al., 2010). While this item accounts for the frequency of alcohol-consumption, the item does not provide information on the intensity of drinking behaviors. The intensity of drinking behaviors during drinking occasions can provide valuable information regarding hazardous patterns of alcohol consumption (e.g., Patrick, Terry-McElrath, Kloska, & Schulenberg, 2016). A more comprehensive measure that includes both the frequency and intensity of alcohol consumption would contribute to greater understanding of relations between variability in positive affect and hazardous drinking patterns.

Furthermore, results from this study do not explore different types of variability displayed in momentary ratings of positive affect. An underlying theoretical assumption of the findings from this study suggests that variability in positive affect reflects responses to changing contexts and that certain affective responses may be adaptive whereas other affective responses may be maladaptive given contextual and person-level factors. Future research is necessary to parse apart which are the most detrimental aspects of variability and whether the affective lability is context-appropriate (Gruber et al., 2013; Kashdan & Rottenberg, 2010).

Finally, this study cannot disentangle the temporal direction of the associations between mean levels of and variability in positive affect and maternal mental health or health risk behaviors. For example, health risk behaviors like frequency of alcohol consumption may influence means levels and variability in affective states (e.g., Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). Future work is needed to better understand the causal links between mean levels and variability in positive affect and mental health and health risk behavior outcomes.

In conclusion, this study is one of the first to investigate the interactive association between mean levels and volatility in positive affect and mental health and health risk behaviors. Results indicate that considering of mean levels of positive affect may be important for understanding how variability in positive affect influences psychological and behavioral outcomes. This study adds to our theoretical understanding of the ways in which variability in positive affect can be adaptive for individuals with low mean levels of positive affect but maladaptive for individuals with high mean levels of positive affect.

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